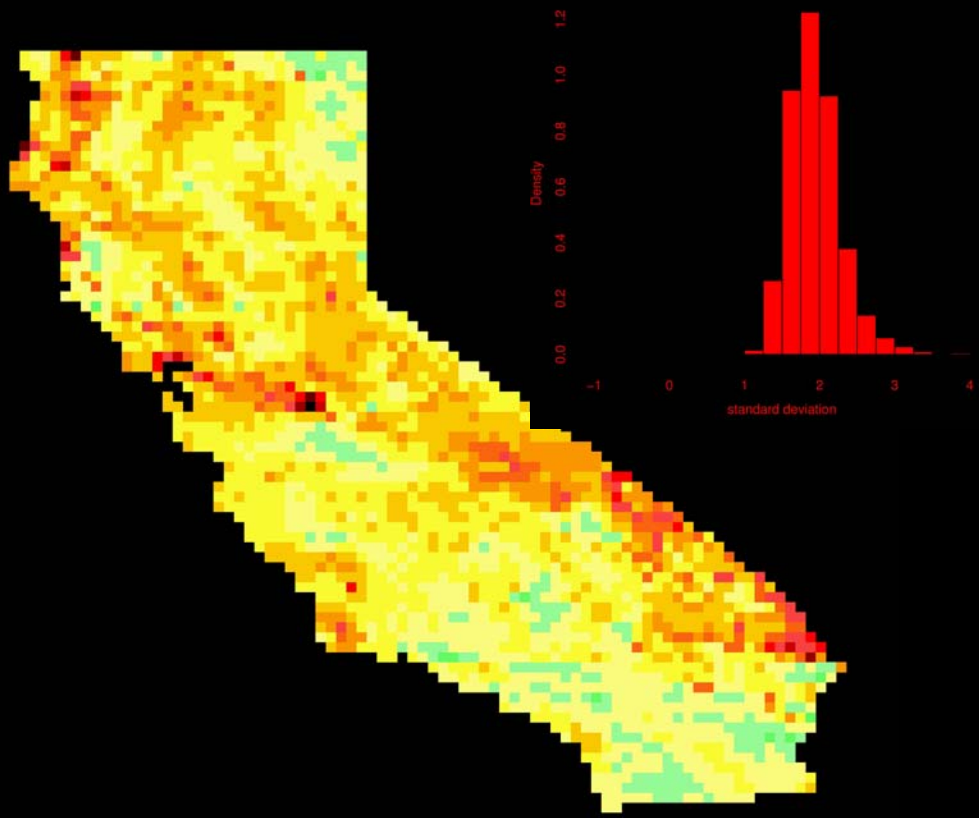
Mapping Vulnerability to Wildfire: Property Losses and Suppression Costs

September 10, 2008

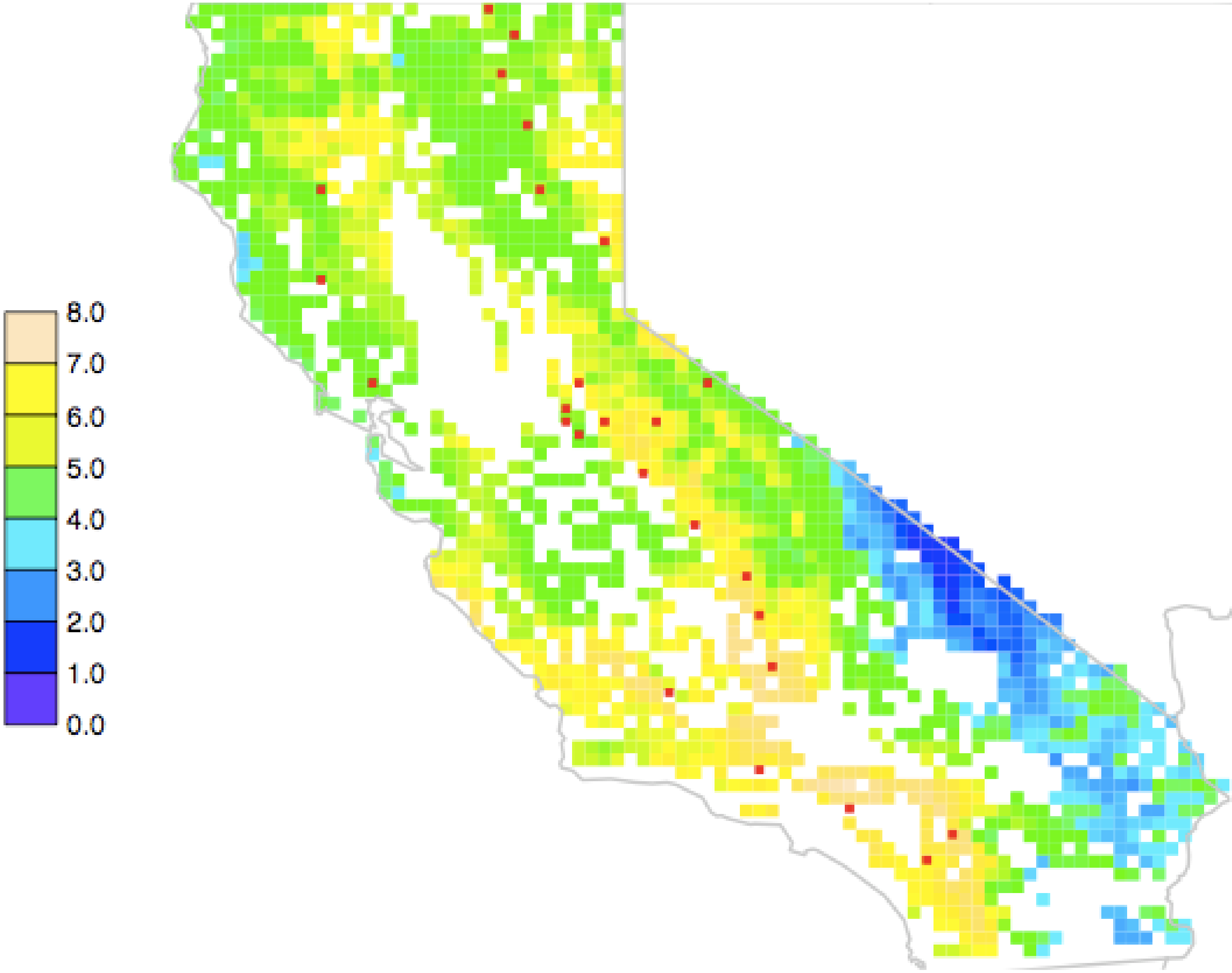
California Climate Change Conference
Sacramento, CA

A. Westerling – UC Merced
B. Bryant – RAND
H. Preisler – USFS

California Energy Commission
NOAA OGP ★ USDA Forest Service



August 1996 observed



Map of Probabilities (%) of > 200ha burn areas
Red dots are observed pixels with >200ha burns

Emissions Scenarios

sresA2

sresB1

Where do we summarize Variability?
vs
Where can we assess the effects of Policy?

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

Development Scenarios

Lo/mid/hi
Population growth

Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services

Emissions Scenarios

sresA2

sresB1

Future Emissions Scenarios are a choice That can be affected by Policy

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

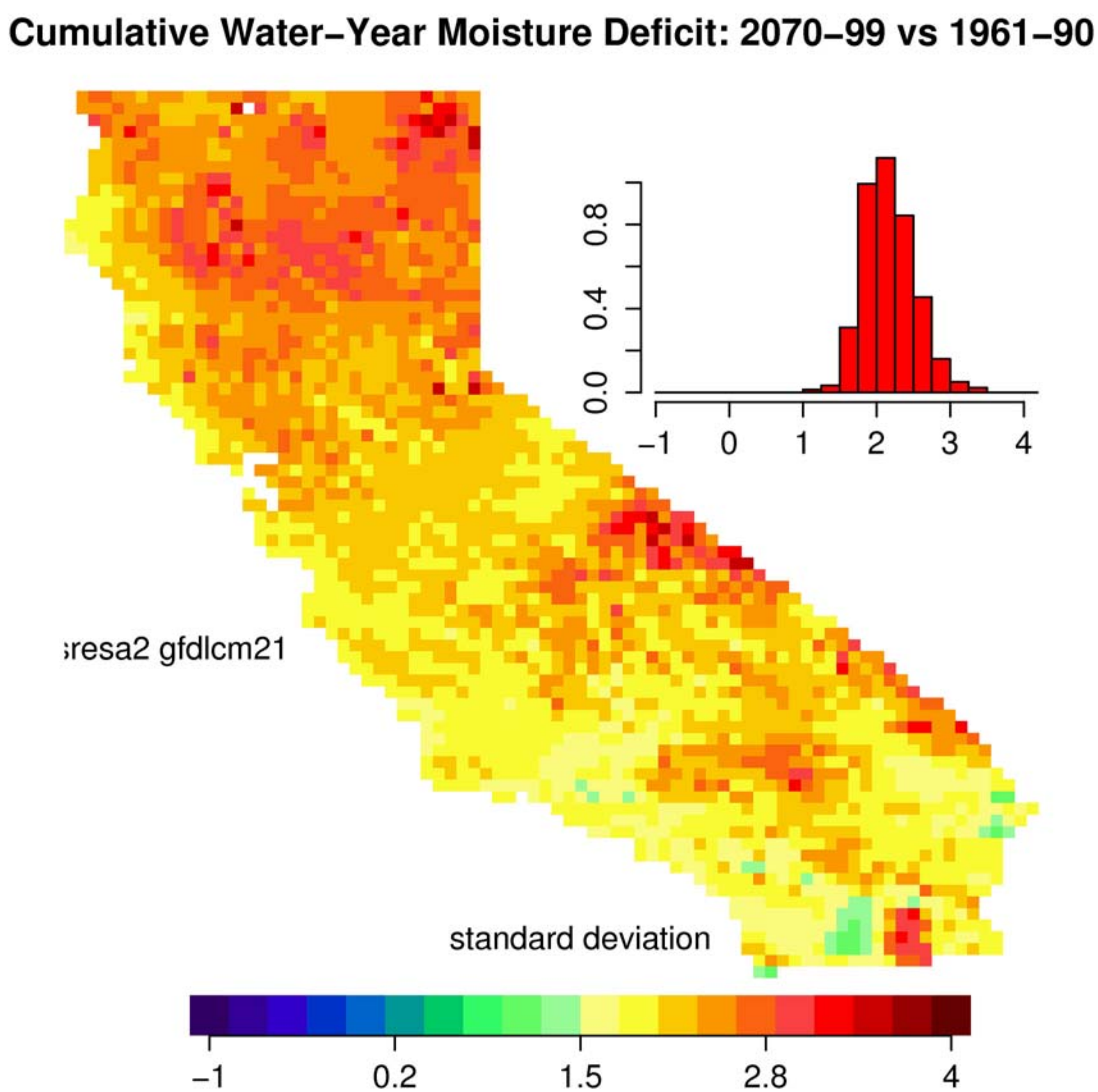
Development Scenarios

Lo/mid/hi Population growth

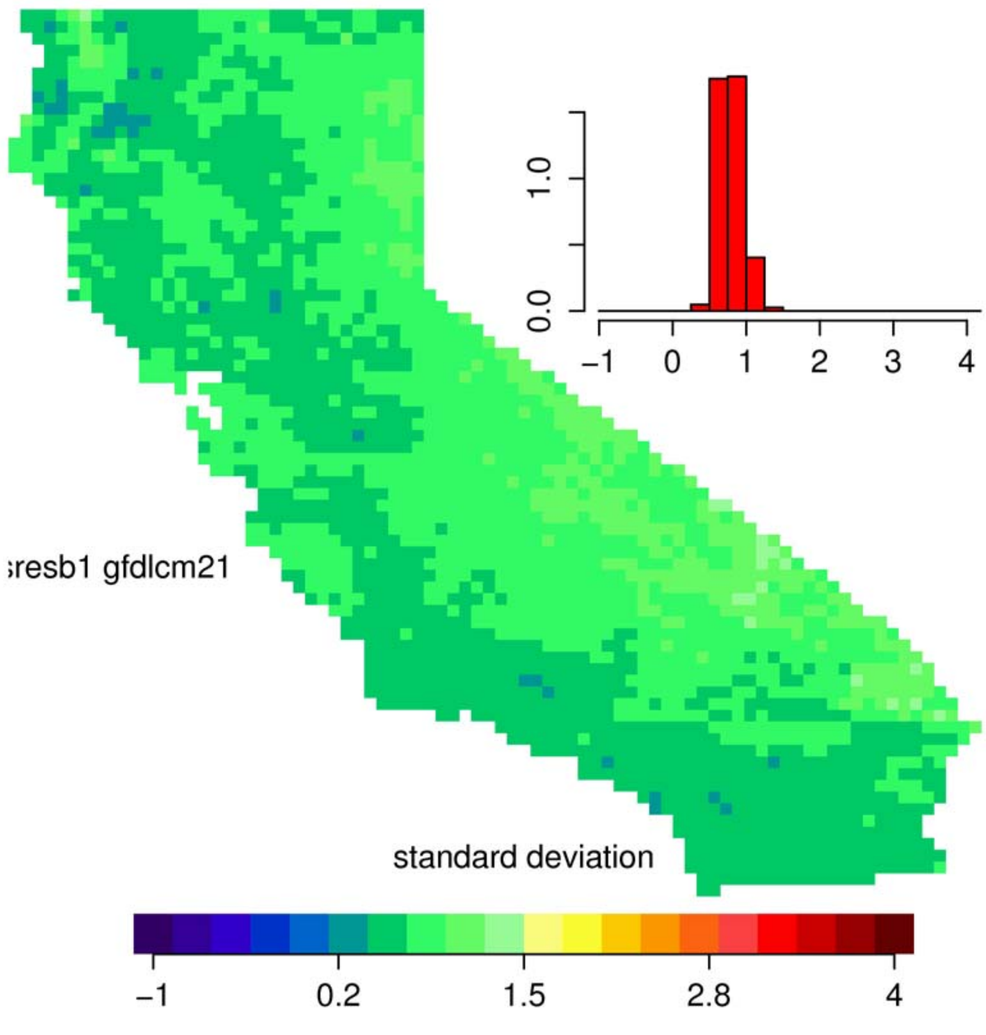
Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services


Cumulative Water−Year Moisture Deficit: 2070−99 vs 1961−90
0.0
0.4
0.8
−1
0
1
2
3
4
sresa2 gfdlcm21
standard deviation
−1
0.2
1.5
2.8
4

Cumulative Water−Year Moisture Deficit: 2070−99 vs 1961−90



Emissions Scenarios

sresA2

sresB1

Variation across climate models
Has important implications for wildfire

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

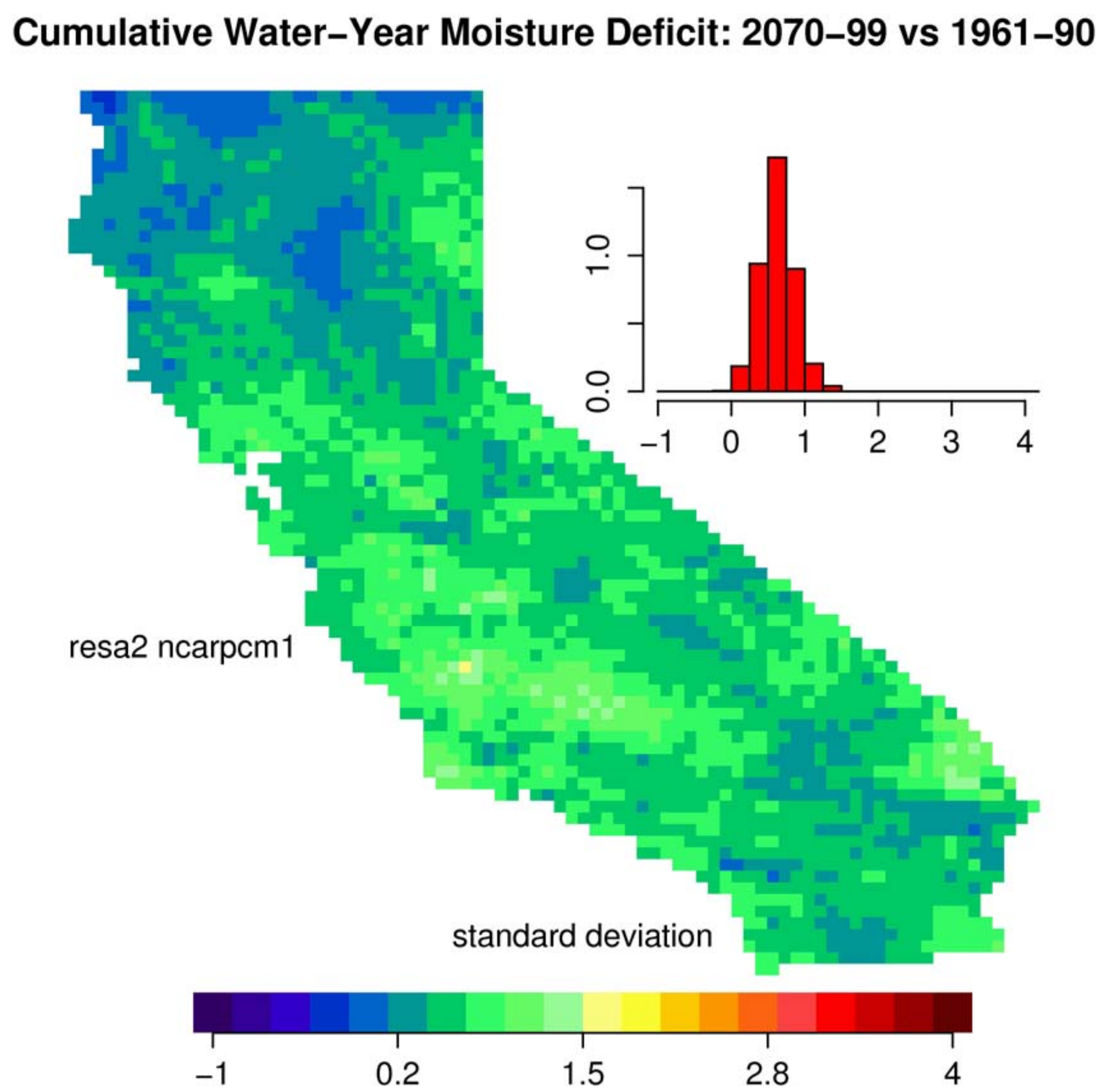
Development Scenarios

Lo/mid/hi
Population growth

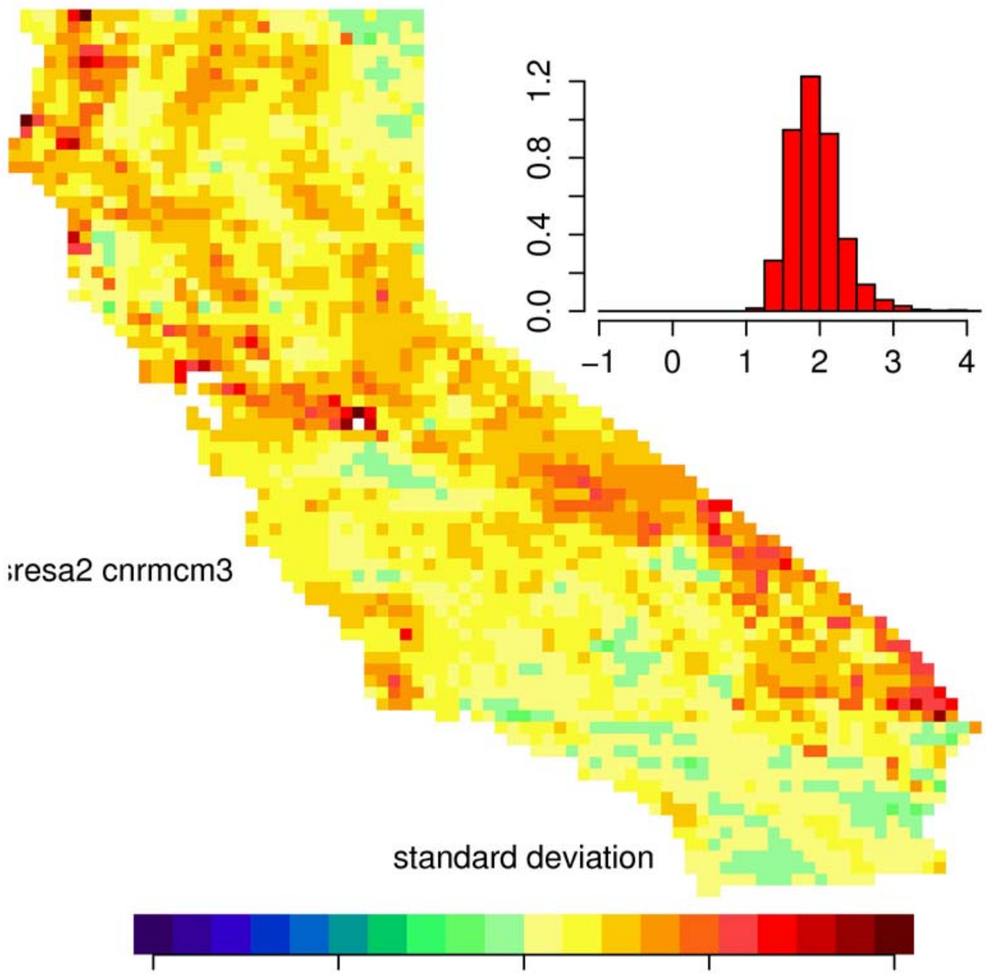
Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services


Cumulative Water−Year Moisture Deficit: 2070−99 vs 1961−90
0.0
1.0
−1
0
1
2
3
4
resa2 ncarpcm1
standard deviation
−1
0.2
1.5
2.8
4

Cumulative Water-Year Moisture Deficit: 2070-99 vs 1961-90



Emissions Scenarios

sresA2

sresB1

Statistical models of wildfire project fire-climate-vegetation interactions of current *managed* fire regimes onto future climate

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

Development Scenarios

Lo/mid/hi Population growth

Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services

Emissions Scenarios

sresA2

sresB1

Current fire and fuels management practice and resource constraints are implicit

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

Development Scenarios

Lo/mid/hi
Population growth

Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services

Emissions Scenarios

sresA2

sresB1

How future growth interacts with changing fire regimes is largely a matter of *Policy*

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

Development Scenarios

Lo/mid/hi Population growth

Clustering/footprint

Impacts

Property Losses
Suppression Costs
Ecosystem Services

Spatial uncertainties regarding urban density

- In theory, there exists some structure density over some spatial scale such that wildfires cannot occur (consider contiguous square mile of pavement and buildings as a limiting case).
- However, neither of these numbers are known with precision, and the “burnability” is a function of the interaction.
  - Eg, “fingering” condo developments with high density at the 250 meter level may be more prone to fire than lower density convex developments

Relevant assumptions differ for fire models versus damage models

- For fire model, we are interested in whether urban development masks out vegetation that would otherwise increase the probability of wildfire ignition
- For damages model, we are interested in the how many structures are distributed at densities which are still consumable by wildfire – ie, not too dense, and not empty.
  - Further interaction between value at risk and likelihood of preservation by fire suppression efforts

Resolve both difficulties through bounding

- For fire probabilities, maximum fire reduction occurs when all new "urban" area is built over vegetated area. Minimum occurs when it is distributed over bare and agriculture land.
- For damage estimates, maximum damage occurs at maximal density that still allows fires to burn through area (WUI).

Emissions Scenarios

sresA2

sresB1

How the risk of fire + potential impacts is resolved is also affected by policy…

Climate Models

cnrmcm3

gfdlcm21

microc32med

mpiecham5

ncarccsm3

ncarpcm1

Downscaling Methods

Analog

BCSD

Hydrologic Modeling

VIC simulation

Fire & Veg Change

statistical modeling

Development Scenarios

Lo/mid/hi Population growth

Clustering/footprint

Impacts

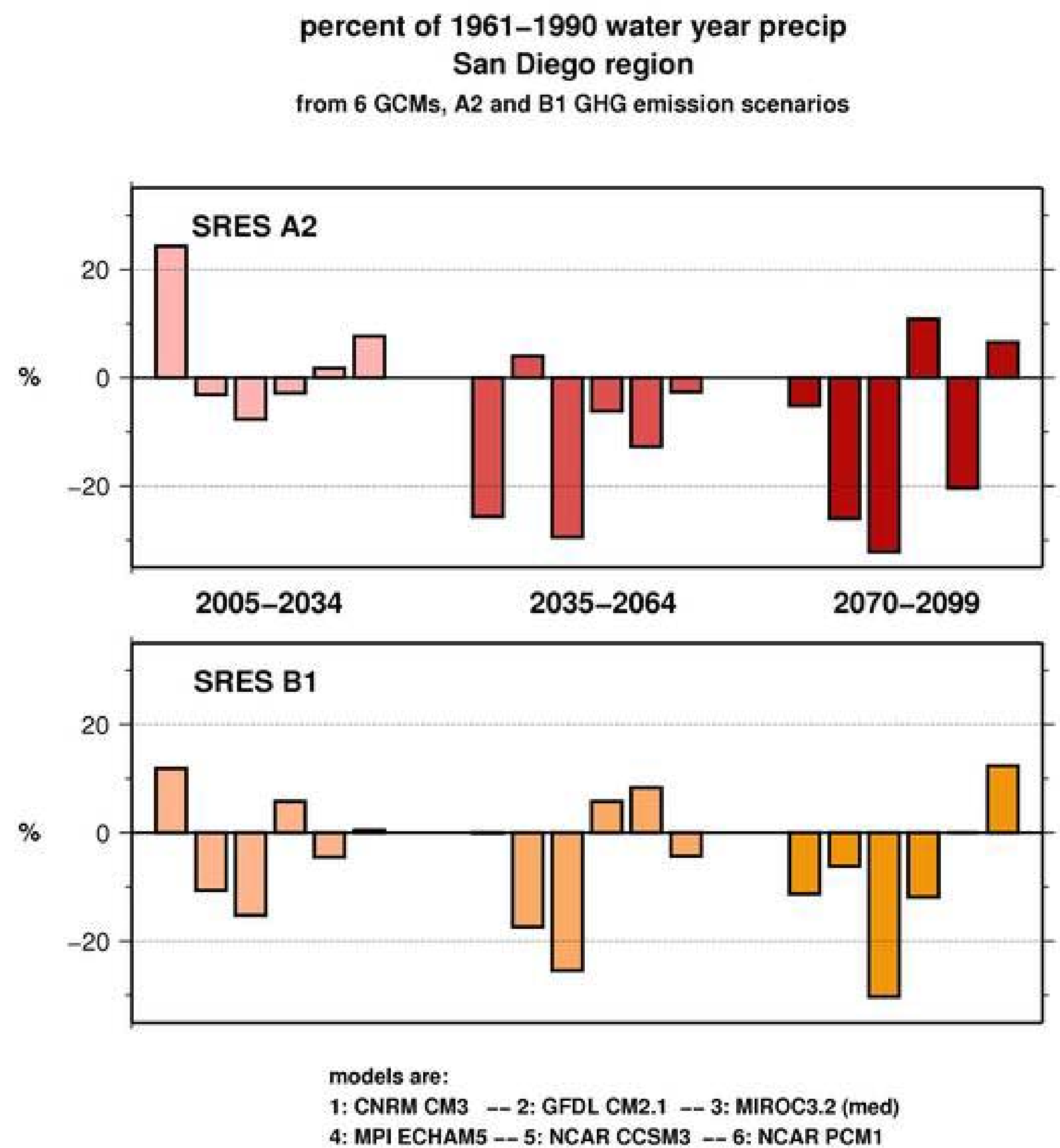
Property Losses
Suppression Costs
Ecosystem Services

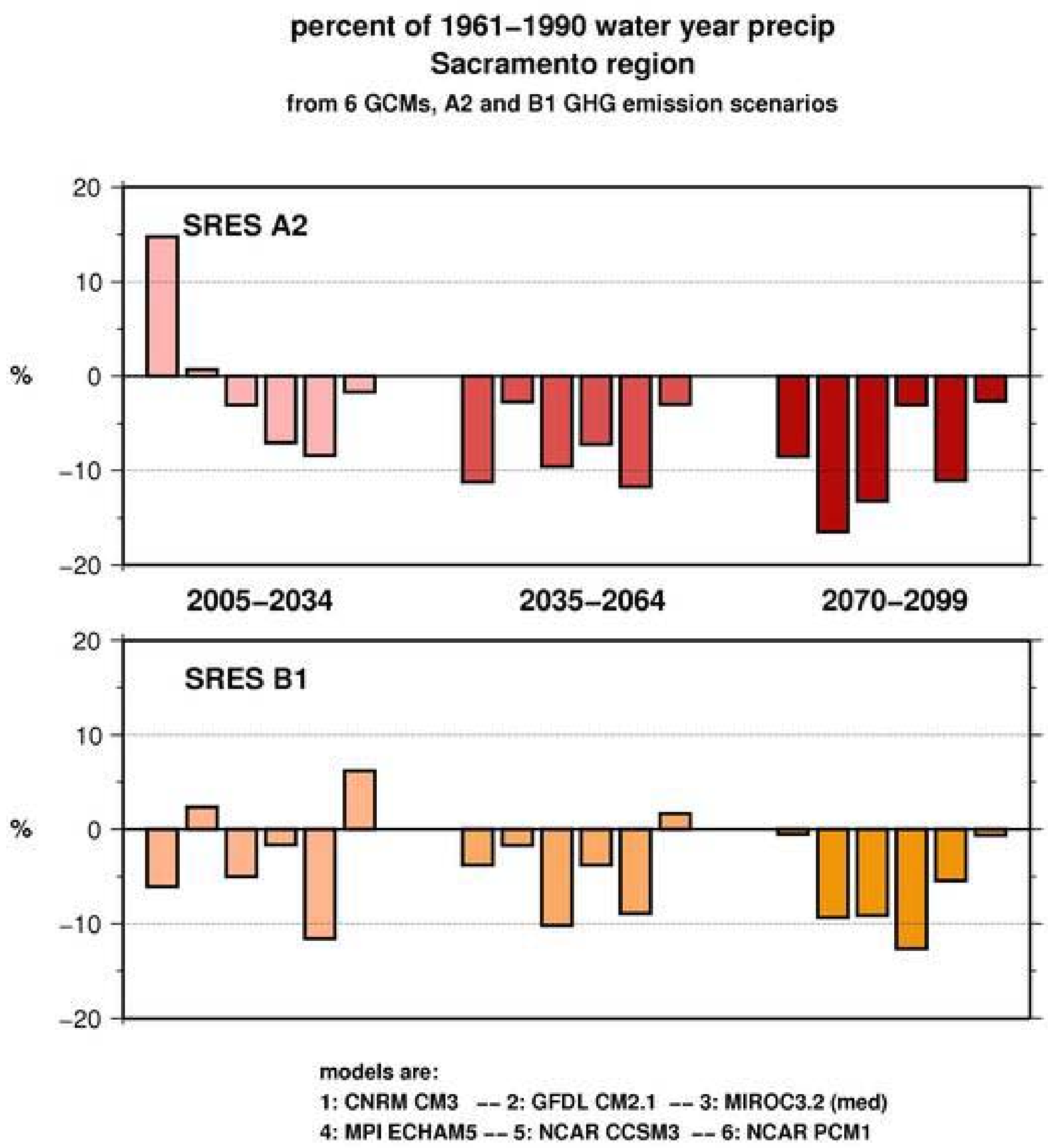
Increased fire probabilities + greater population = ?

- Zoning: will we restrict growth of the WUI?
- Prevention: can we reduce property losses and suppression costs by ‘fire-proofing’ new development?
- Current system is very costly. How much increased fire risk could we ‘accommodate’ with a less costly system? How do we get there?

There is a BIG difference between impacts on property losses and ecosystem services

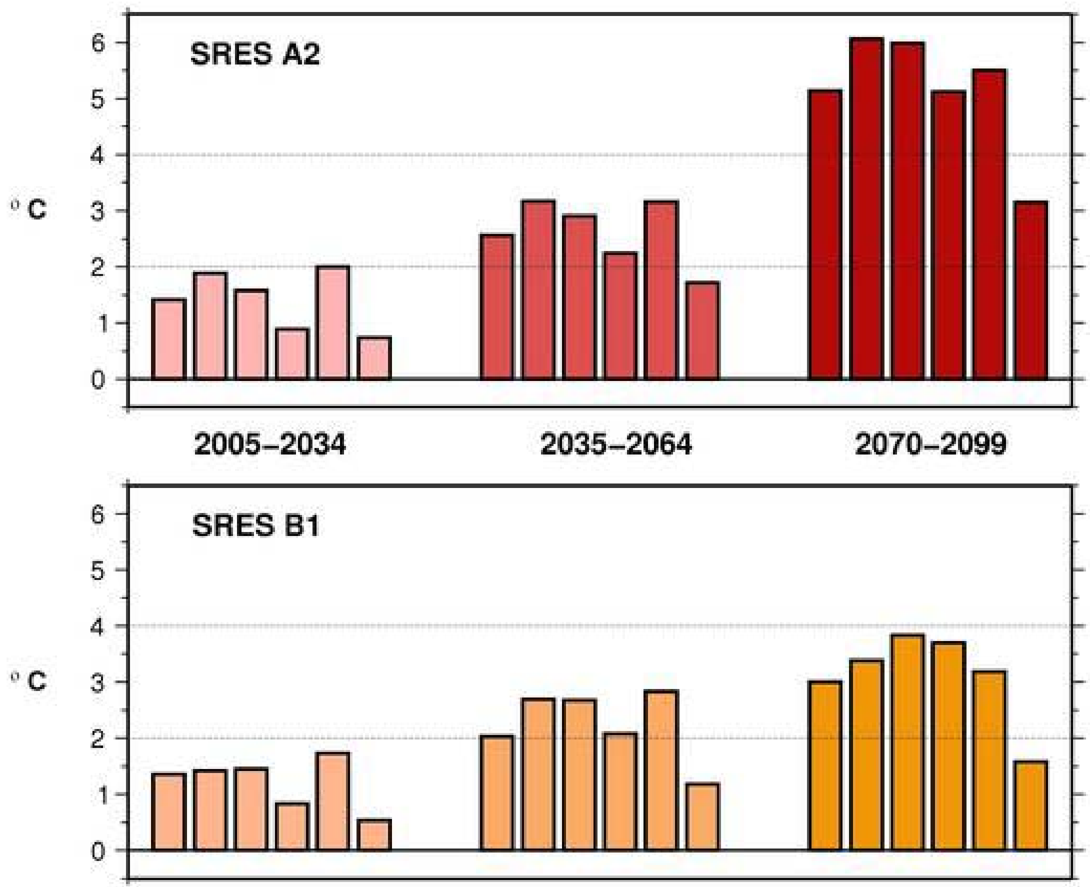
- Air Quality
- Watershed
- Carbon storage
- Habitat
- Heritage/Esthetic/Recreational values
- … will these drive more aggressive ecosystem (fire and fuels?) management?


percent of 1961–1990 water year precip
San Diego region
from 6 GCMs, A2 and B1 GHG emission scenarios
SRES A2
20
%
0
−20
2005–2034
2035–2064
2070–2099
SRES B1
20
%
0
−20
models are:
1: CNRM CM3 -- 2: GFDL CM2.1 -- 3: MIROC3.2 (med)
4: MPI ECHAM5 -- 5: NCAR CCSM3 -- 6: NCAR PCM1

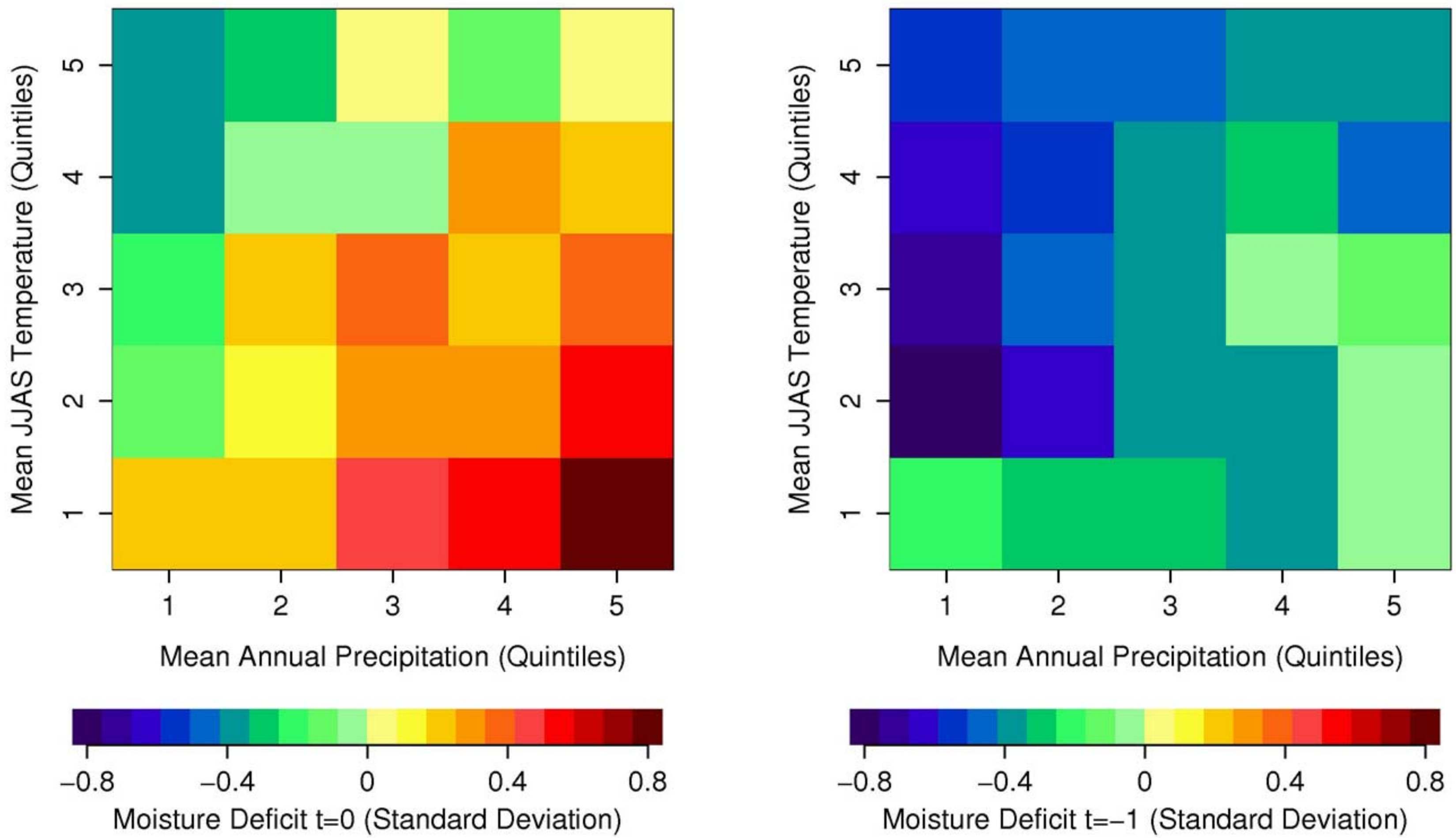


percent of 1961–1990 water year precip
Sacramento region
from 6 GCMs, A2 and B1 GHG emission scenarios
SRES A2
SRES B1
%
20
10
0
–10
–20
2005–2034
2035–2064
2070–2099
models are:
1: CNRM CM3 -- 2: GFDL CM2.1 -- 3: MIROC3.2 (med)
4: MPI ECHAM5 -- 5: NCAR CCSM3 -- 6: NCAR PCM1

Jul–Aug–Sep temperature change from 1961–1990
Sacramento region
from 6 GCMs, A2 and B1 GHG emission scenarios

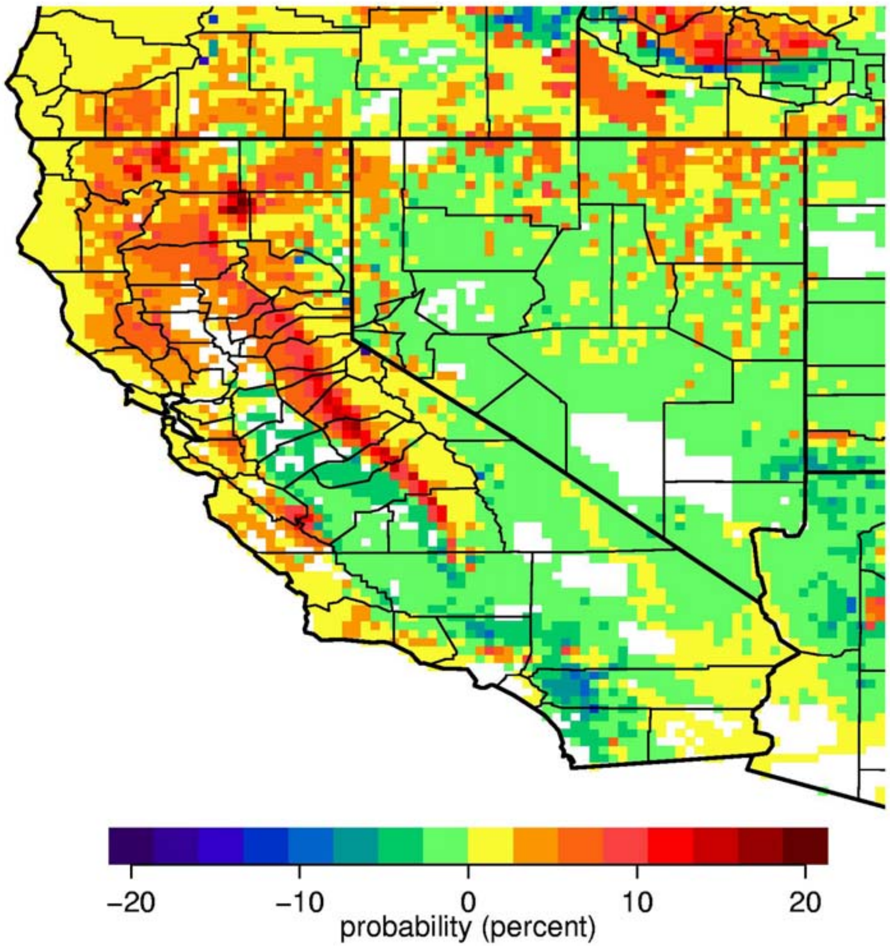


models are:
1: CNRM CM3 -- 2: GFDL CM2.1 -- 3: MIROC3.2 (med)
4: MPI ECHAM5 -- 5: NCAR CCSM3 -- 6: NCAR PCM1

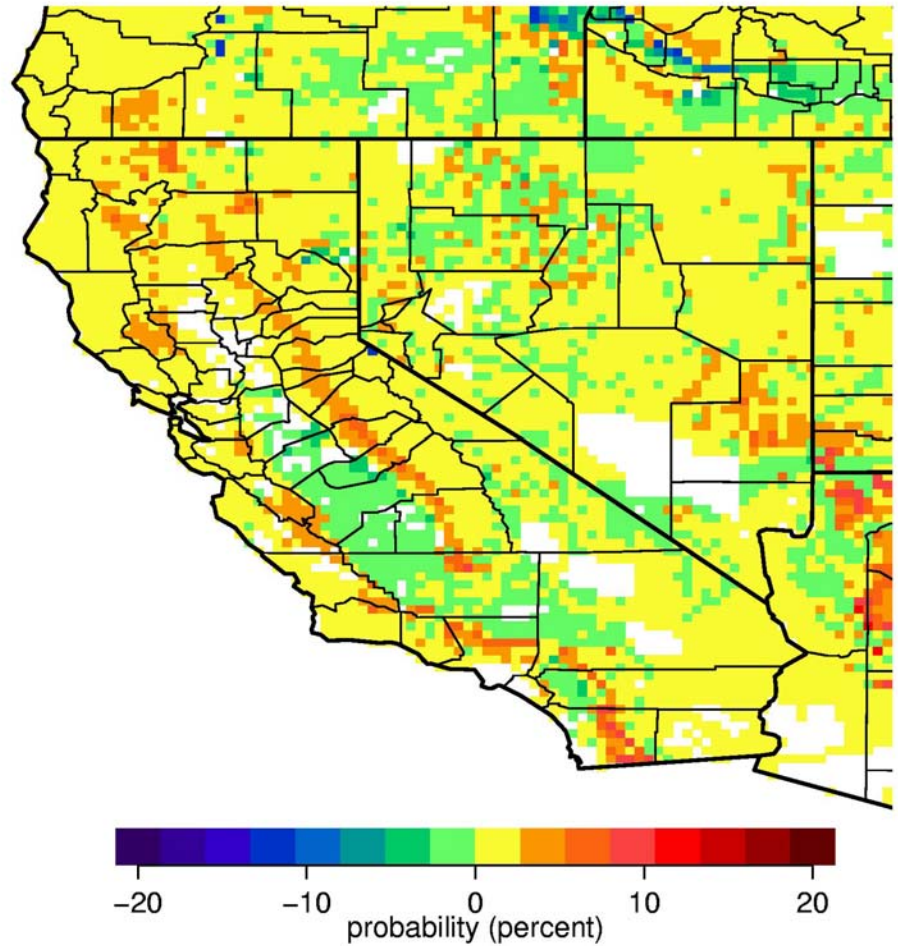


Mean JJAS Temperature (Quintiles)
Mean Annual Precipitation (Quintiles)
1
2
3
4
5
−0.8
−0.4
0
0.4
0.8
Moisture Deficit t=0 (Standard Deviation)
Moisture Deficit t=−1 (Standard Deviation)

A2 GFDL



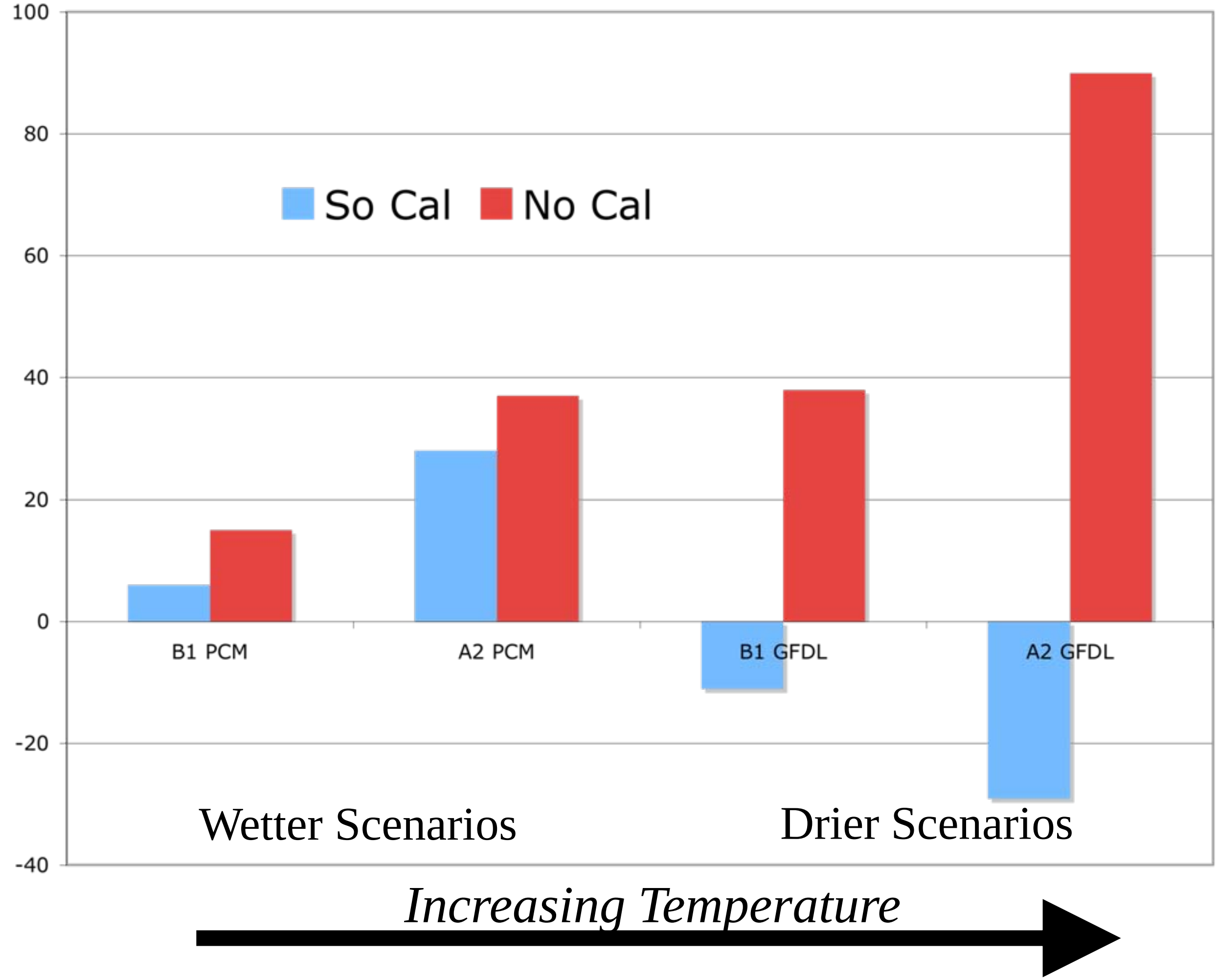
A2 PCM

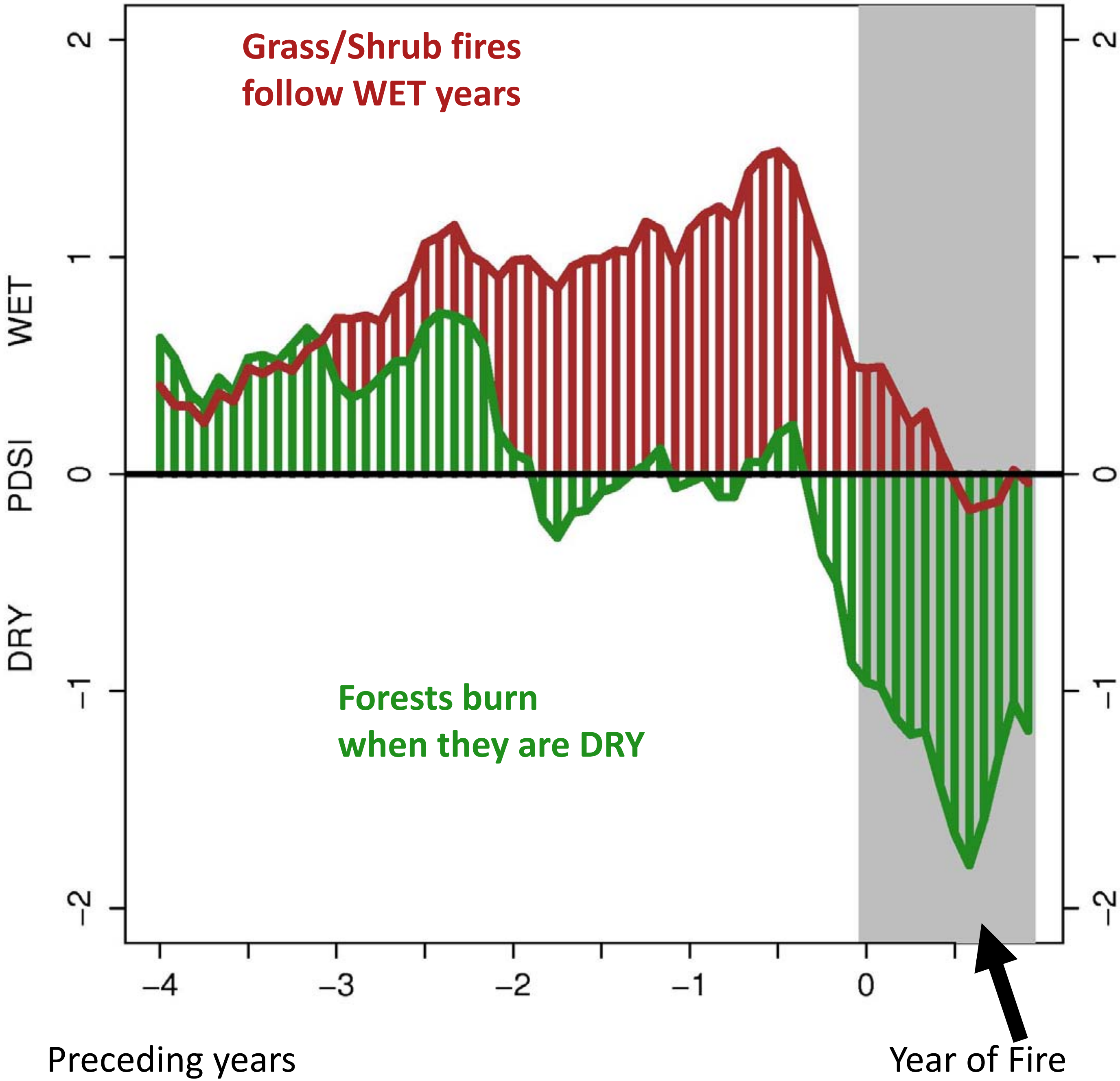


Different Impacts Within CA

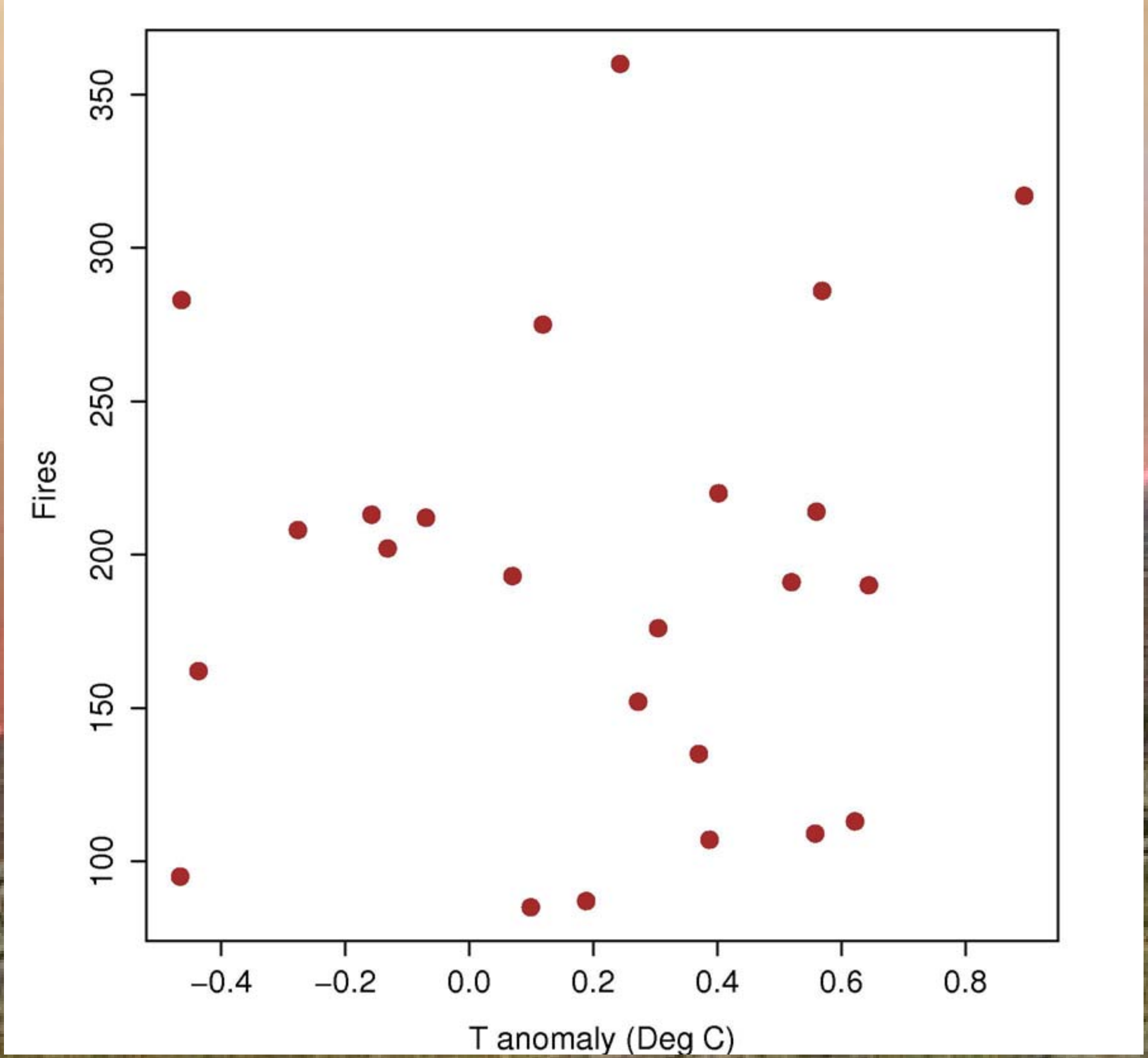
The Greatest **Increased** CA Wildfire **Risks** are Concentrated **in North**ern California

Greater Uncertainty for Wildfire Risks **in South**ern California

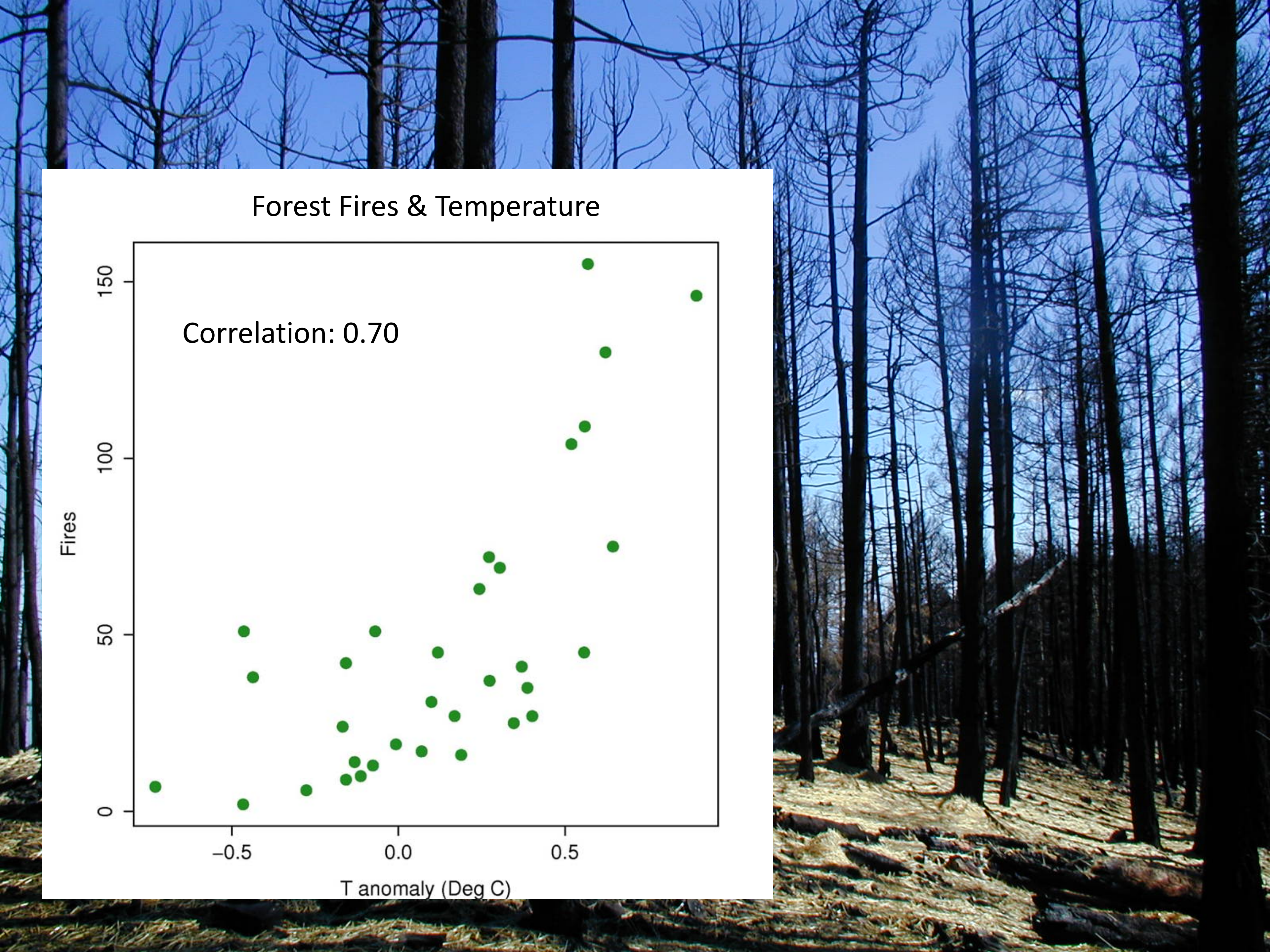



Grass/Shrub fires
follow WET years
Forests burn
when they are DRY
WET
PDSI
DRY
2
1
0
−1
−2
−4
−3
−2
−1
0
Preceding years
Year of Fire

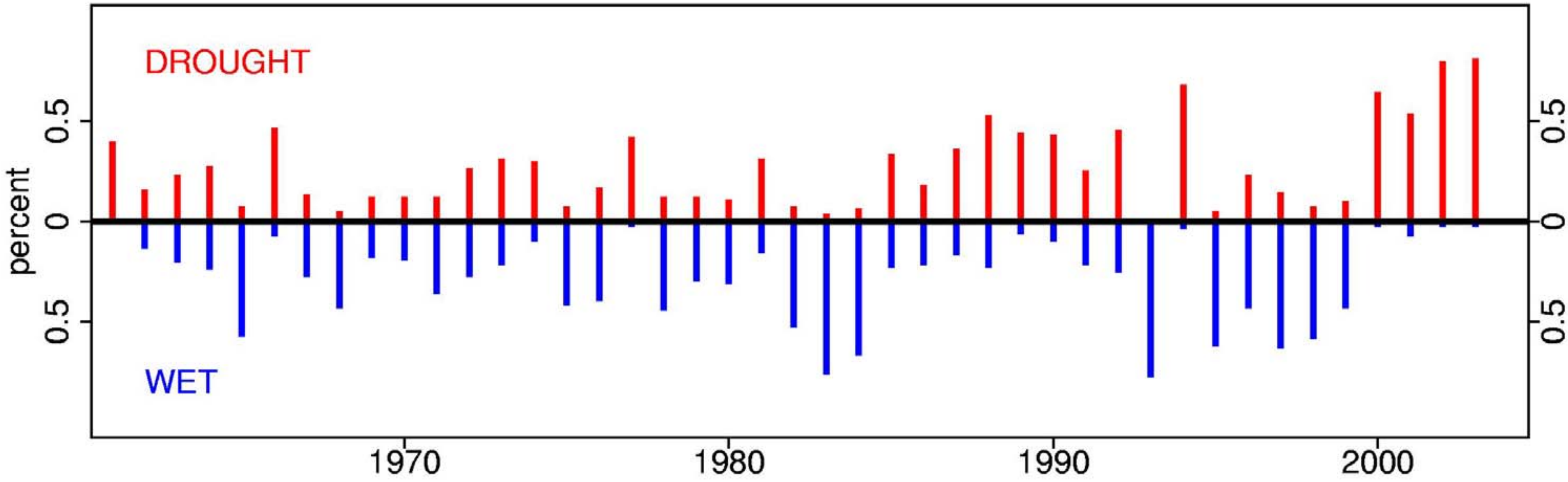
Grass/Shrub Fires and Temperature



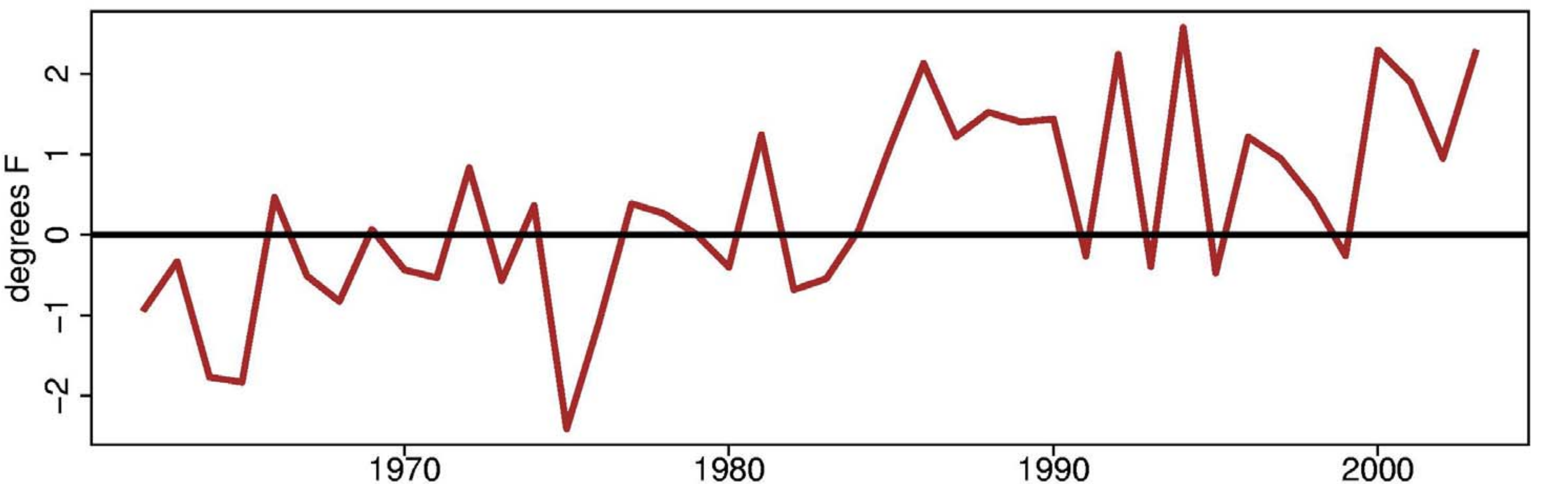
Correlation: 0.08

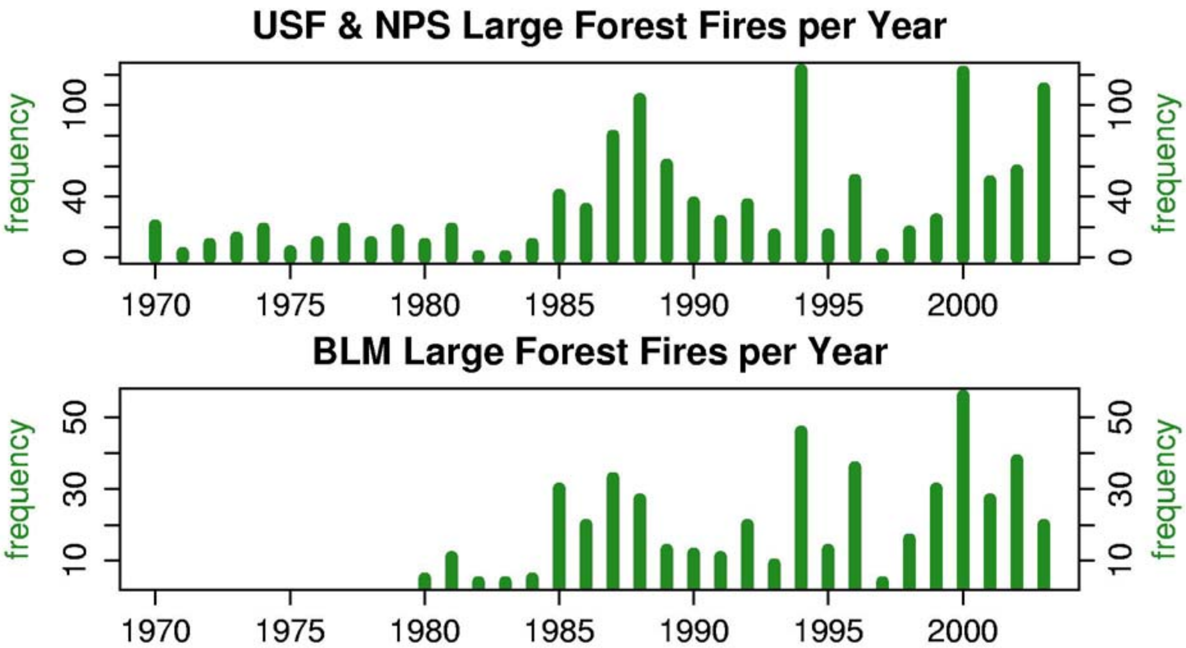

Forest Fires & Temperature
Correlation: 0.70
Fires
0
50
100
150
−0.5
0.0
0.5
T anomaly (Deg C)

Percent of West in Drought or Wet Conditions



Mean Western MAMJJA Temperature





Since the mid-1980s

Large Forest Wildfires Have Increased ~300%

Other Large Wildfires Have Not Changed Substantially